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An Analysis on Error Concealment Techniques And Intra Prediction Methods

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Abstract— In Digital video processing, the problem of complexity and quality in error control and concealment in video communication is becoming an important issue because of the Exponential increasing interest in video delivery over wireless channels in which high definition (HD) resolution, represent huge amounts of data. To achieve better quality without error and without using extra bandwidth video compression is required. The newly emerging Video coding standard H.264/AVC and its main aim is to achieve higher compression with reduced redundancy and irrelevant information. Error concealment have feature that transmits Lossless video without introducing retransmission delay In this paper reviewed all error concealment techniques and describe post processing technique which don't involve extra bandwidth with decreases coding efficiency compared to other techniques described in reviewed .Main concentration in this paper on to reduced redundancy different predictive coding are used. This paper reviews Comparative analysis of prediction methods and its selection method which select particular mode and after that generate residual frame after applying compression technique on residual reconstructed frame will be generated.

Keywords- H.264, Error concealment, Post Processing, Intra prediction, Macro Block (MB)

I. INTRODUCTION

Since, the evolution of video compression technology Demands of video applications are increasing exponentially. As, working with video or image processing have to take care of each and every pixels or bit. While transmitting HD video with high resolution main concern is quality and accuracy with compression is also required other than Bandwidth and storage space are important parameters in video communication. There are two major groups are actively participating in enhancement of video codec, first is Video Coding Experts Group (VCEG) from ITU-T, and the other is Moving Picture Experts Group (MPEG) from International Organization for Standardization (ISO)/International Electro-technical Commission (IEC). A previously developed video codec standards, like H.120 developed in 1984 by ITU-T. It is lossy. The newer standard defined in 1990 by ITU-T, is called H.261. It is mainly use for video conferencing and telephony. ISO/IEC also released MPEG-1 part 2 in 1993, which is implemented in video CD. In 1995 ITU-T and ISO/IEC jointly released their new video codec known as H.262, popular in Video CD/DVD/Blu-ray, Video broadcasting. In 1995, H.263 and 1999 MPEG-4 part 2 are developed by ITU-T and ISO/IEC respectively. Finally, H.264 video 2 codec was announced by ITU-T and ISO/IEC, which is popular for all applications mentioned above [1].Now, to satisfy and Expanding video application newly developed video compression standard H.264 is to be more effective than previously developed standards. It is the standard that is interoperates with both encoder and decoder. There are four main strategies for eliminating the image quality degradation effect by transmission errors [3], including

(1) the channel coding strategy, (2) the error resilient (preprocessing) strategy, (3) the encoder-decoder interactive error control strategy, and (4) the error concealment (post processing) strategy. This flexible choice of coding parameters leads to efficient compression at the expense of computational complexity because the encoder needs to evaluate a large number of mode options in order to determine the coding parameters that produce maximum compression efficiency.

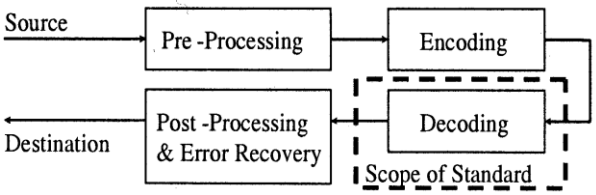

Figure 1. Scope of video coding standardization[1]

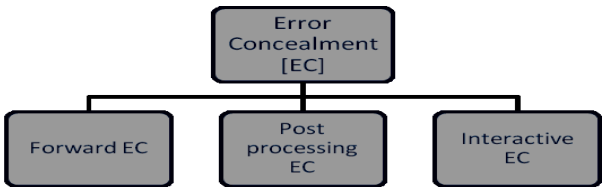

Figure 2. Techniques of EC

II. ERROR CONCEALMENT

From many years every communication system has to face difficulties that may increases during transmission, such as bit insertion, Quality degradation, deletion or inversion. While using error correction technique the problem occurs can be reduced without using extra bandwidth. Error concealment is one of the technique that gives Lossless video without introducing retransmission delay.This technique is at decoder side have been developed to recover the damaged region utilizing spatial & Temporal redundant information without changing the encoder structure or adding extra bandwidth. Error concealment techniques [2] majorly dividing in three categories (see Figure 2). It devoting its work according to the their roles.

- Forward Error Concealment(FEC) – performed by the encoder ;
- Post processing Error Concealment (PEC)– performed by the decoder;
- Interactive Error Concealment(IEC) – performed jointly by the encoder and decoder

From that all techniques FEC gives has low error rate but it increases coding efficiency compared to other techniques while in IEC because of its functioning of working with both the side it require feedback and its complexity mainly depends on the system. Post processing is only the technique in which coding efficiency is reduced without involving extra B.W with tradeoff of Complexity.

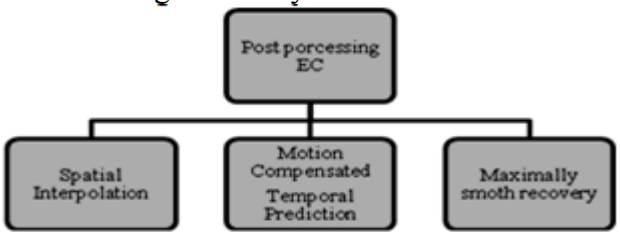

Figure 3. Techniques of Post processing EC

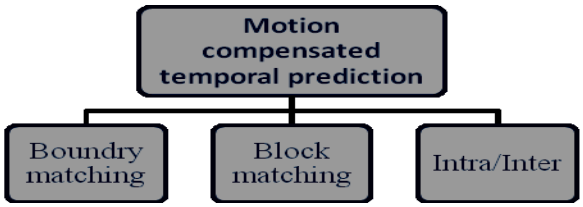

Figure 4. Methods of Motion compensation prediction

III. POST PROCESSING ERRORCONCEALMENT

When errors occur, to make the best possible with the correctly received information. The way to work in this situation is to realize that a real video signal varies more smoothly both in space and time, which means that temporal and spatial information were correctly received, in the neighborhood of the affected area of an image, can be used to dissimulate the effects of the transmission errors. Post processing includes format conversion, filtering to suppress coding artifacts, error concealment, or video enhancement [11]. It recovers the damaged area based on characteristics of image or video signals. Post processing is technique in which recovery from error at decoder side by estimation and interpolation .In which no need for additional "Redundant"

information. But the disadvantage of this technique is its complexity. Post processing is classified into three major section techniques (see Figure 3) and their Comparative analysis (see Table 1).

IV. MOTION COMPENSATED TEMPORAL PREDICTION

In this technique if in case an error occurs, it substitutes the affected area by information of the previous/within frame. The simplest implementation uses the same spatial area, of the previous frame, to replenish the affected area. However, this method only achieves good results when there is slow movement over the video sequence, otherwise, it can give unpleasant visual results. Better results can be achieved if the motion compensated block is used instead of the block in the Same spatial area [7]. This compensated block is the one identified by the motion vectors of the affected block. As (see Figure 4) these techniques have another three major methods which has different application with different algorithms. First of all Block matching method is used to estimates the motion vector in the current frame and in this method size of block is affect the estimation of motion vector. Small block size produced more raw motion information. Now, in Boundary matching method it compares outer pixels of erroneous block with inner pixels of reference block to find the most similar block [9]. Intra prediction is the technique in which the samples of MBs are predicted using utilizing information of already transmitted MBs of the same frame. In H.264/AVC, mainly two different types of intra prediction are possible for the prediction of the luminance component Y. From that first type is prediction can be perform with block size of 4x4 that having 9 modes to calculate while in 16x16 that is the another type of prediction the frame that having 4 modes needed to be calculated. All the types of intra prediction and its tradeoff are reviewed in section 5.

Table 1. Comparative analysis of Post processing technique

Spatial Interpolation	**Motion compensated temporal prediction**	**Maximally smooth recovery**
Simple but can cause over blurring	Simple	Intermediate complexity
Require block interleaving at the source end	gives good result if MVs of damaged blocks are available	give good result, can deal with any loss patterns
Cannot make use of temporal correlation	Results are less reliable with estimated MV	Exploit both spatial & Temporal domain correlation

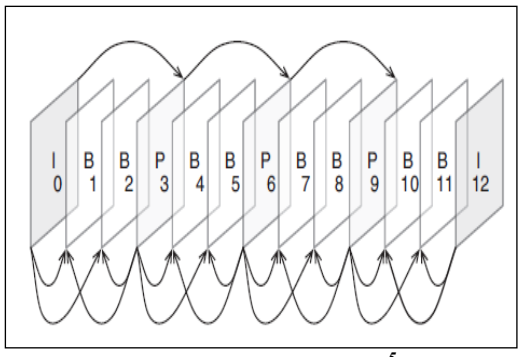

Figure 5. Group of picture(GOP) [5]

V. INTRA FRAME CODING

Inter frame and intra frame coding are two methods of redundancy compression that have been used to good effect in the development of video processing [10]. It is also possible to extract information about differences between spatially nearby pixels at a given instant in time. This process of intra frame coding makes large areas. Intra prediction is applied to remove spatial redundancy within the frame. Intra mode prediction is selected if there is not enough temporal redundancy in the two frames. The intra only uses spatial prediction and inter uses temporal prediction that is in between the frames. The prediction taken within the frame called I frame. The prediction taken from past called P frame and if from future frame is called B (bidirectional Frame).The sequence of all the frame can be look like in(see Figure 5) is called group of picture (GOP) [5].

A. Intra 4x4 prediction Modes

In 4x4 luma prediction all modes are predicted for each 4x4 (MB).As, use the smaller block size it gives better prediction region with tradeoff of gives few residual data and require more bits for coded the prediction choice. Intra mode have 9 modes (see figure 7) that is calculated using equations (see Figure 6) .

B. Intra 16x16 prediction Modes

Unlike 4x4 prediction mode, intra-16x16 predictions requires four directional prediction modes which use reconstructed pixels at top and to the left of the macro block to predict current block. Compared to 4x4 this 16x16 need less bits for coded and have more residual data. Large block size mostly used in flat areas that do not contain much detail.

This all modes of 4x4 and 16x16 have some mathematical equation that can be implemented using MATLAB tool. Comparative analysis of both this Block size and Intra/Inter prediction can be described in (see Table 2 and Table 3).

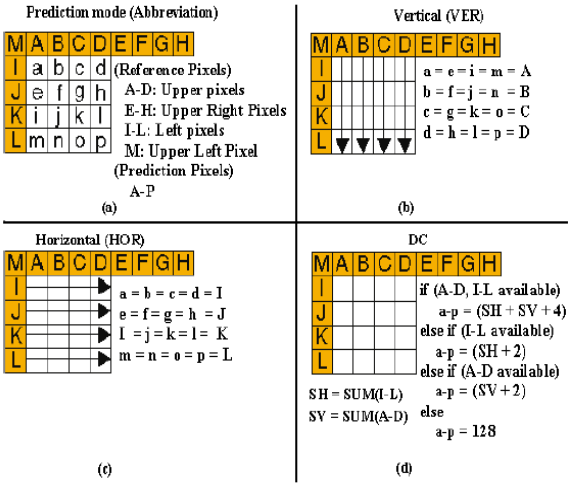

Figure 6. Intra prediction mathematical Interpretation[8]

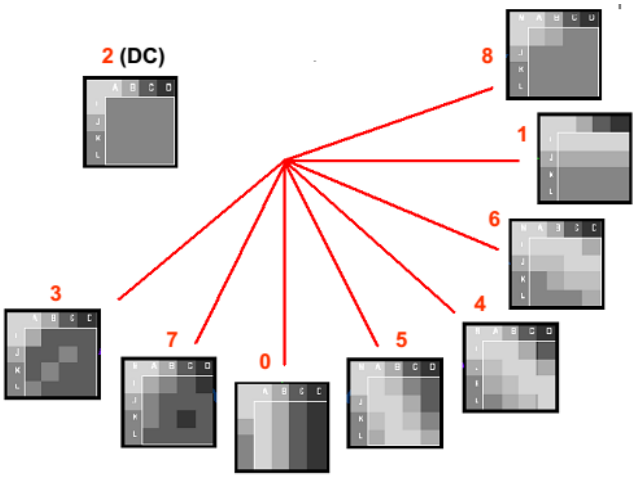

Figure 7. Intra 4x4 modes[8]

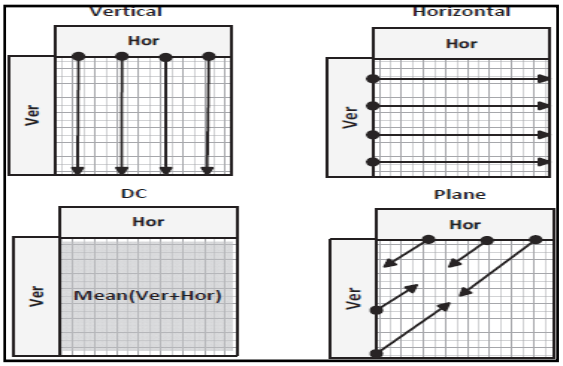

Figure 7. Intra 16x16 modes

Table2. Comparative analysis of Blocksizes[4, 5]

Smaller blocks[4x4]	Larger block[16x16,8x8]
More accurate prediction, Few residual data, More bits tend to be required to code the prediction choices. Used for texture region	Less accurate prediction, More residual data, Fewer bits are required to code the prediction choice itself. Used for flat region

VI. INTRA PREDICTION SELECTION METHODS

In this proposed algorithm of applying prediction modes is Based on Availability of Neighboring for both the [4x4,16x16] After Appling all related modes to a particular block from all the mode which mode should be preferable for current block that Concluded on basis of certain methods.

A. Sum of Squared Difference (SSD)

SSD is widely utilized algorithm for calculating the similarity. Compared to SAD algorithm these have large complexity due to the multiplication. It is the sum of squared difference between the current block S and the evaluated block C, and it is expressed by

$$SSD = \sum_{i=0}^{N}\sum_{j=0}^{N}|S(i,j) - C(i,j)|\text{^}2$$

B.Sum of Absolute Difference (SAD)

SAD algorithm is the simple system where the absolute difference between the corresponding block and original block is added and the smallest SAD value among the SAD blocks is considered as the similarity image. Equation for calculating SAD for Particular block should be listed bellow [12]

$$SAD = \sum_{i=0}^{N}\sum_{j=0}^{N}|S(i,j) - C(i,j)|$$

Main advantage of SAD is that it is required only addition, difference between the pixel values.

Now, after selection of modes should be completed the difference taken between Current Block and Reconstructed Block generate residual Block and it is going through Transformed (DCT) and then Quantized. After Appling Inverse process data has been added with predicted Block and Reconstructed Frame is generated.

VII. CONCLUSION

From this analysis it was conclude that various techniques have been described for performing Error Concealment in real-time video communication. Depending on channel error characteristics and system configuration and requirements, some techniques are more effective than others. From which Post-processing error concealment techniques do not involve extra redundancy and can be applied at any video system. While concealment in intra frame is done it can't propagates error to another frame in video that's the main advantage over Inter frame prediction. In Intra prediction larger blocks size and smaller block size both having different application and from review it can be conclude that it has tradeoff between residual data and bitrates. After Completion of prediction the selection method describes in paper that sum of Absolute difference (SAD) and sum of Squared difference (SSD)as per the literature choose SAD as per their advantage of giving good PSNR with minimum complexity.

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